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Ministry of Economic Development
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CERTIFICATE

This certificate is issued in support of an application for Patent registration in a country outside New Zealand pursuant to the Patents Act 1953 and the Regulations thereunder.

I hereby certify that annexed is a true copy of the Provisional Specification as filed on 9 May 2001 with an application for Letters Patent number 511606 made by SUMMIT-QUINPHOS (NZ) LIMITED.

Dated 28 November 2003.

Neville Harris
Commissioner of Patents, Trade Marks and Designs

COMMISSIONER OF PATENTS, TRADEMARKS & DESIGNS
NEW ZEALAND

330 High Street, Lower Hutt and 17 Toop Street, Seaview
PO Box 30687, Lower Hutt, New Zealand or DX SX 11129, Wellington
Phone: +64 4 560 1600, Fax: +64 4 560 1691, www.iponz.govt.nz

511606

NEW ZEALAND

PATENTS ACT, 1953

PROVISIONAL SPECIFICATION

"Fertiliser Compositions"

We, **SUMMIT-QUINPHOS (NZ) LIMITED,** a company duly incorporated under the laws of New Zealand of 1A Matai Road, Greenlane, Auckland, New Zealand, do hereby declare this invention to be described in the following statement:

The present invention relates to fertilisers.

Urea is a frequently used fertiliser as a source of ground and/or plant nitrogen.

Sulphur-coated urea products have been developed and are considered to be useful because

1) urea being a high nitrogen containing product, even when coated, still results in a product having a nitrogen content of about 30 to 40% by weight;
2) sulphur coating of urea reduces leaching of nitrate and volatilisation of nitrous oxide and ammonia;
3) sulphur coating of urea therefore improves the efficiency of utilisation of the nitrogen in the urea;
4) sulphur is relatively cheap; and
5) sulphur is itself a valuable secondary nutrient.

Some sulphur coating procedures rely on the addition of additional agents in order to achieve an effective coating whilst others rely upon a melt application procedure. Dry coating procedures have a disadvantage in that the coating even prior to application can become cracked, in which case it breaks off the urea and the coating benefits are lost.

The present invention recognises the prospect of a simple procedure being utilised to provide an effective coating of urea using sulphur and which additionally has the advantage of being capable of being used in conjunction with the incorporation of nitrification inhibitors and also urease if required. It is to this therefore that the present invention is directed.

In a first aspect the present invention consists in **a particulate fertiliser composition** of particulate urea (eg; granules or prills) coated with wetground sulphur.

Preferably said wet ground sulphur has been dewatered to some extent (typically 5 - 20% moisture) prior to the association of such sulphur particles with the urea particles.

Preferably said sulphur particles serially or simultaneously are associated with said urea with a nitrification inhibitor.

In another aspect the present invention consists in **a particulate fertiliser composition** of particulate urea coated with both sulphur and a nitrification inhibitor.

Preferably said sulphur is wet ground sulphur.

Preferably at least 90% of the said sulphur is of particle size from 10 to 150 microns (preferably of a medium particle size of about 75 microns).

Preferably said urea is in the form of (standard or other) granules or prills and each such particle (ie; granule or prill) has a weight of sulphur plus moisture plus inhibitor added (expressed as a % of the total weight of prill or granule) in the range of from 10 to 25%.

Preferably said nitrification inhibitor is selected from the group consisting of DCD

(dicyandiamide) or DIDIN™ (a DCD containing product of SKW, Germany which also includes ammonium thiosulphate and ammonium phosphate).

Preferably the nitrification inhibitor is incorporated as a fine particle or as a solution.

Preferably the weight percentage of nitrification inhibitor relative to sulphur is in the range of from 10% to 50%.

Preferably the weight percentage of sulphur relative to urea is from 5% to 15%.

Preferably said sulphur at the time of its association with the urea has a water content of from 8% to 15%.

Preferably the coating of the urea is with a mixture of the sulphur and the nitrification inhibitor.

Preferably said product has been formed by combining sulphur (that has been ground underwater and subsequently de-watered) with the nitrification inhibitor and the subsequent mixing of that mixture with the urea.

In still a further aspect the present invention consists in **a urea based fertiliser** being or having urea granules coated to provide a surrounding matrix of both sulphur and a nitrification inhibitor, the sulphur binding into the urea to create a mixed urea/sulphur transition zone which may (and preferably does) include some of said nitrification inhibitor.

In still a further aspect the present invention consists in **a fertiliser** in granule, prill or the like form having a core of urea, an inner peripheral zone of both at least urea and sulphur and an outer peripheral zone of both at least urea and sulphur and an outer peripheral of at least sulphur.

Preferably one or both of said peripheral zones includes a nitrification inhibitor.

In still a further aspect the present invention consists in **a method of preparing a fertiliser from particulate urea** (eg; granules or prills) which comprises or includes mixing such particulate urea (serially and/or simultaneously) with a wetground elementary sulphur and a compatible nitrification inhibitor.

Preferably said mixing is simultaneous, ie; the wet ground and de-watered sulphur having previously been mixed with the preferably particulate nitrification inhibitor.

Preferably the characteristics of the nitrification inhibitor, the sulphur and the urea and their relativities are substantially as previously stated.

In still a further aspect the present invention consists in **a urea granule or prill based fertiliser** having a surround which includes both elementary sulphur and a nitrification inhibitor, the sulphur binding or assisting in the binding of the nitrification inhibitor to the urea.

Preferably said sulphur was wet ground sulphur.

In still a further aspect the present invention consists in **the fertiliser usage of a fertiliser composition or urea based fertiliser product** as previously stated, ie; by its application to a locus of the ground to be fertilised.

This invention may also be said broadly to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, and any or all combinations of any two or more of said parts, elements or features, and where specific integers are mentioned herein which have known equivalents in the art to which this invention relates, such known equivalents are deemed to be incorporated herein as if individually set forth.

Preferred forms of the present invention will now be described with reference to the accompanying drawings in which;

Figure 1 shows typical breakdown chemical reactions of urea which generates both N_20 and ammonia in addition to forms of nitrogen which can be utilised by plants, and

Figure 2 shows a flow diagram of a preferred process in accordance with the present invention, etc.

As used herein the term "wet grinding" in relation to sulphur involves any physical modification of the sulphur by physical or mechanical means in a liquid environment and preferably water with a view to size reduction.

Details of one such procedure developed by M W Brown of New Zealand Pastoral Agriculture Research Institute Limited (possibly subsequently assigned to High Tech Products Limited and subject to their NZ Patent Application 337251) was disclosed in the Agritech 2000 TV Programme 18 recorded 5 September 1997 and broadcast in New Zealand.

The aforementioned TV Agritech 2000 TV Programme 18 makes reference to a milkshake type dispersing apparatus to reduce the size of the sulphur in water. They attributed to that crude disperser process the prospect of size reduction dependent on water to sulphur ratio, dependent on duration of disperser use and dependent on speed of the disperser in to the there depicted accumulations of 0.25 mm, 0.15 mm, 0.075 mm and less than 0.075 mm wet ground sulphur.

A suitable disperser for such purpose could be that as used in that programme or that subsequently used by High Tech Products Limited. Other suitable dispersers for such a process are those of IKA and Silverson.

It is to the production of such size reduced sulphur with its consequential characteristics that the term "wet grinding" (or variations of the term) relates even if it is not what would be considered as grinding or milling if in a dry environment.

The de-watering step referred to in Figure 2 is preferably no more than a physical de-watering procedure such as might occur by pouring the sulphur slurry into porous bags and

applying pressure to force excess water out and thereafter conditioning the resultant moist solids to break up soft lumps of sulphur.

The mixing procedure can be in any suitable blending apparatus for the initial introduction of the nitrification inhibitor. Likewise the same or a different mixing or blending apparatus can be used for blending the urea into (as preferred) the pre-existent mix of the wetground sulphur and the nitrification inhibitor.

The resultant product, which is a pale yellow in appearance, otherwise has much the same physical appearance of uncoated urea granules or prills and has similar free flow characteristics without any ready tendency to shed the coating.

DATED THIS 9th DAY OF May 2001

A J PARK

Per

AGENTS FOR THE APPLICANT

Chemical reactions involving urea and its reaction products in the soil

(a) Hydrolysis of urea to ammonium

$(NH_2)_2CO$ + H_2O $\xrightarrow{\text{urease enzyme}}$ $(2NH_4)_2\ CO_3$ (1)

urea; water in soil; ammonium carbonate

$(NH_4)_2CO_3$ $\underset{\text{dependent}}{\overset{\text{condition}}{\rightleftharpoons}}$ NH_4^+ + $NH_3(\uparrow)$ + $CO_2(\uparrow)$ + OH^- (2)

NH_4^+: ammonium ions; $NH_3(\uparrow)$: ammonia gas; $CO_2(\uparrow)$: carbon dioxide gas; OH^-: hydroxide

(b) Oxidation of ammonium to nitrate ("nitrification")

$2NH_4^+$ + O_2 $\xrightarrow[\text{bacteria}]{\text{Nitrosomonas}}$ $2NH_2OH$ + $2H^+$ (3)

$2NH_2OH$ + O_2 $\longrightarrow$ $N_2O(\uparrow)$ + $3\ H_2O$ (4)

$N_2O(\uparrow)$: nitrous oxide gas

$2N_2O$ + $2O_2$ + $2\ H_2O$ $\xrightarrow[\text{bacteria}]{\text{Nitrosomonas}}$ $4NO_2^-$ + $4H^+$ (5)

$4NO_2^-$: nitrite (transient)

$2NO_2^-$ + O_2 $\xrightarrow[\text{bacteria}]{\text{Nitrobacter}}$ $2NO_3^-$ $(\downarrow)$ (6)

$2NO_3^-$: nitrate (leachable)

Notes

Reaction (2) gives rise to losses of ammonia gas (NH_3)
Reaction (4) gives rise to losses of nitrous oxide gas (N_2O)
Reaction (6) gives rise to leaching of nitrate (NO_3^-)
Reaction (2) gives rise to temporary increase in pH
Reactions (3) and (5) give rise to ultimate decrease in pH

- Urease "inhibitor" acts by slowing the rate of reaction (1)
- Nitrification "inhibitors" act by slowing some or all of reactions (3) – (6)
- Sulphur-coating reduces the speed with which the conversion of urea to other products can take place, principally by slowing contact of the urea with water and oxygen

FIGURE 1

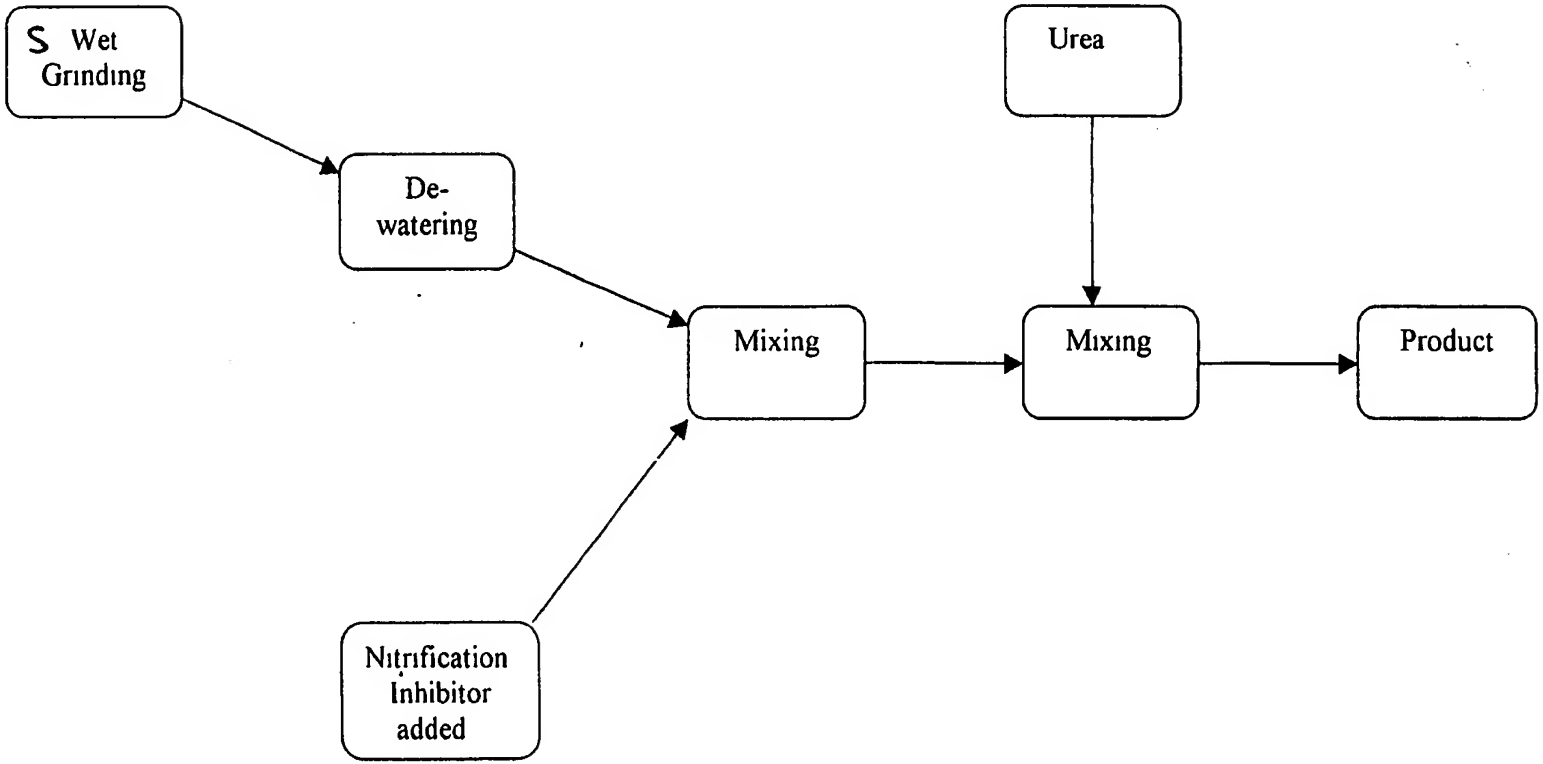
S Wet Grinding
De-watering
Urea
Mixing
Mixing
Product
Nitrification Inhibitor added

FIGURE 2